SYSTEM IDENTIFICATION AND ADAPTIVE SELF-TUNING CONTROL FOR IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM

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Dedicated to the entire BALLA’s

And to all those that believed in me

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ABSTRACT

Pipeline infrastructure has become a very popular tool for transferring and distributing oil, gas and raw materials. Many of these pipelines extend along hundreds of miles and pass through remote, harsh and corrosive areas. This raises the prospect of cracks in their walls and cause leaks. In case of pipelines fail due to corrosion resulting in leakage, they will often lead to loss of products followed by environmental and financial damages on a national scale. Therefore, protecting materials and structures against corrosion is a significant issue especially in tropical countries such as Malaysia which has high humidity climate (corrosiveness factor). This latest, promotes the need for specialized research to be done for preventing corrosion. Consequently, in this study we have focused on the most practical method of cathodic protection systems which is impressed current cathodic protection (ICCP) system. This system is widely used to prevent the external corrosion of carbon steel structures; especially those are used in underground pipelines. Basically, in this project the theoretical background and the concepts of ICCP systems have been discussed. An effective laboratory scale for ICCP systems was built according to specific concepts has been clarified. Then, parametric model of ICCP systems was obtained using system identification approach. Furthermore, to enhance the performance of ICCP systems, proportional-integral (PI) and direct self-tuning generalized minimum variance (ST GMV) controllers have been designed. Additionally, simulation and experimental works have been carried out to control ICCP systems at different operating conditions. Finally, the ST GMV controller leads to improve the system speed response and to decrease the integral of absolute error, which is lower value compared to close loop using PI controller.

ABSTRAK

Infrastruktur paip telah menjadi peralatan yang penting untuk memindah dan mengedarkan minyak, gas dan bahan-bahan mentah. Kebanyakkan paip-paip ini dipasang diunjurkan jauh sehingga beratus-ratus kilometer. Ada diantara paip-paip ini melalui kawasan-kawasan pedalaman, termasuk juga kawasan yang berdepan dengan hakisan. Ini meningkatkan kemungkinan berlaku retakan dan seterusnya kebocoran. Sekiranya kegagalan sistem perpaipan ini adalah disebabkan oleh hakisan yang disebabkan oleh kebocoran, ini selanjutnya akan mengakibatkan kerugian produk, dan kerosakan alam sekitar juga termasuk peningkatan dalam kerugian kos pada skala peringkat kebangsaan. Oleh yang demikian, bagi negara tropika seperti Malaysia yang mana iklimnya panas dan lembap, keperluan untuk melindungi material dan struktur daripada hakisan adalah amat penting. Dalam kajian ini, fokus kami adalah menggunakan kaedah yang paling praktikal dalam sistem perlindungan katod, iaitu sistem perlindungan katod arus teruja (ICCP). Sistem ini digunakan secara meluas untuk mengelakkan hakisan luaran oleh struktur keluli karbon; terutamanya untuk perpaipan didalam tanah. Pada asasnya, didalam projek ini, latar belakang teori dan konsep sistem ICCP telah dibincnagkan.satu makmal efektif untuk sistem ICCP telah dibina berdasarkan konsep tertentu telah dijelaskan. Kemudian, model parametrik sistem ICCP telah diperolehi dengan menggunakan sistem pengenalan identiti. Tambahan pula, untuk meningkatkan prestasi sistem ICCP, pengawal penalaan perkadaran dan penalaan kamiran (PI) juga penalaan diri langsung dengan varians minimum umu (ST GMV) telah direka. Akhirnya, ST GMV pengawal mampu memperbaiki kelajuan tindak balas sistem dan mengurangkan kamiran kesilapan mutlak, yang merupakan nilai yang lebih rendah berbanding menggunakan pengawal PI gelung tutup.